DISTRIBUTION, INCIDENCE, AND DAMAGE CAUSED BY PITCH CANKER DISEASE IN SLASH PINE PLANTATIONS ON THE APALACHICOLA NATIONAL FOREST, FLORIDA, 1982. TRENDS IN DISEASE DEVELOPMENT, 1977 THROUGH 1981.

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ABSTRACT

In March 1982, a survey of slash pine stands on the Apalachicola National Forest showed pitch canker disease to be substantively unchanged over the previous survey conducted in 1980. Plantations between 8 and 16 years old had the highest disease incidence. Mean disease incidence in heavily diseased stands was 33 percent. Evaluation of the disease occurrence over the previous seven years showed that one-third of the slash pine plantations have a tendency to be infected at high levels in most years, one-third remain disease-free or lightly infected, and one-third conditionally susceptible to the disease. No obvious association existed between disease incidence and forest fertilization, site index, or suitability-for-site.

INTRODUCTION

Pitch canker disease, caused by the fungus Fusarium moniliforme Sheld. var. subglutinans Wr. & Reink., damages trees of all of the important southern pine species in forest stands, seed orchards, ornamental settings, or forest tree nurseries. Currently, slash pine (Pinus elliottii Engelm. var. elliottii) is the only species damaged at economic levels in forest stands over a large geographic area. Incidence and damage are most severe in stands below economic rotation age for pulpwood. Epidemics have periodically damaged slash pine plantations in Florida since the 1940's. The most recent and severe occurred in 1976-79 and resulted in salvage harvesting of several thousand acres in the state.

In slash pine, fungus infection most often occurs on the current year's growth of the terminal and upper laterals. Pitch soaked cankers result, which girdle susceptible branches. Recently killed shoots are reddish-brown, with needles adhering. Infective spores produced on diseased branches are dispersed in the air most abundantly in summer, but are present at all times of the year. The deodar weevil (Pissodes nemorensis Germ.) can vector the fungus, but its importance is unknown. Growth loss from the elimination of photosynthetic area

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is the major damage impact, but stem deformity due to repeated terminal mortality could account for large dollar losses from product value devaluation (rendering sawtimber stands to pulpwood management objectives). Trees killed by massive crown infection rarely account for more than 2 percent of all trees in pitch cankered stands.

The Apalachicola was surveyed by Forest Pest Management in 1982 as a continuation of previous surveys (1976, 1978, 1980) to determine the current status of the disease on the Forest. The first portion of this report presents the findings of the March 1982 survey. The results of comparable surveys are then considered together and trends in disease development and associations with certain management practices and stand parameters are discussed.

METHODS

A grid was established on the Forest, using the secondary road system. Roads were spaced 5 miles apart, and survey stands were to be no less than 3 miles apart on the roads. Criteria for selection as a sample stand were; 1) at least 50 percent of the stocking in slash pine, 2) continuous stand boundary containing at least 5 acres, and 3) a subjective judgement that the stand was adequately, but not overstocked. The first stand encountered fitting the selection criteria was surveyed, and the road grid was traveled in a systematic manner.

If no disease was observed when walking the road boundary of a sample stand, only stand age and origin were recorded. If disease was observed at low levels and a tally of 150 trees indicated disease incidence at less than 5 percent, only stand age and origin were recorded. For stands with equal or greater than 5 percent incidence (Incidence Above Trace Levels [IATL] stands), the Yandle-Roth ratio estimation survey method (4) was employed, and the following data were recorded for the first 100 trees in each of 3 randomly selected rows/transects.

For each transect:

1. Stand number
2. Stand age
3. Stand origin (natural or seeded; planted)

For each tree:

1. d.b.h. (if > 4")

2. Infection (separate codes for current and previous symptoms)

    a. healthy
    b. terminal infection only
    c. lateral infection only
    d. b and c

3. Crown involvement (% crown killed)

a. trace
b. trace - 25%
c. 26-50%
d. > 50%
e. dead - pitch canker
f. dead - other

The locations of survey stands were carefully plotted on forest maps. The entire road grid was traversed, with a target of 50 survey stands for the Forest.

Trends in Disease Development, 1976 through 1981

The initial pitch canker disease survey of the Apalachicola National Forest was conducted in 1976 as part of a Florida-wide survey of National Forest lands. Survey stands were randomly selected from Forest records, such that two stands were chosen from each of six, 5-year age classes, beginning with 5 year old stands. Planted and natural stands were included in the population and presumably were selected in proportion to the number of stands in each origin class for each age. Twelve stands were surveyed on each Ranger District. Five, 25-tree transects were evaluated in each stand (125 trees per stand). Infection data were recorded for each tree.

Surveys conducted in 1978 and 1980 followed nearly identical methodology to the 1982 survey methods described earlier.

Precise stand locations and tabulation of stand parameters and management practices were accomplished from National Forest records for nearly all stands in 1982, but only for IATL stands in 1980 and 1978. Maps of 1976 survey stands were not available. Stand age, fertilization, site index, and an estimation of suitability of the site for slash pine (did existing forest type agree with future management type?) were considered.

RESULTS AND DISCUSSION

Survey results for 1982 are presented in Table 1. Fifty-seven stands were surveyed on the Forest's two Ranger Districts. The Apalachicola District contained nine more survey stands than the Wakulla, a reflection of the larger acreage of slash pine type along the survey roads. There was a higher proportion of IATL stands on the Apalachicola District, but mean infection of stands in that category was higher on the Wakulla (49% Wakulla vs. 27% Apalachicola). Seventy-five percent of surveyed stands were infected with pitch canker.

Diseased trees were present in most age classes and in both planted and naturally regenerated stands, but IATL stands were restricted to plantations less than 19 years old. Average infection in IATL stands Forest-wide was 33 percent.

Since pitch canker leaves evidence of past infection for at least two growing seasons in most cases, it was possible to assess the current year's disease symptoms (killed between summer 1981 to survey date) as separate from previous years'. In most IATL stands, current infection (symptoms expressed in

Table 1.--Age, stand origin, and pitch canker disease status of slash pine stands surveyed on the Apalachicola National Forest, Florida, 1982.

Stand #	Age (yrs)	Origin 1/ (N,P)	Infection		Crown Rating 2/				Potential Stem Deformity 3/	
			Total	Current	a & b	c & d	e	dead-other	81T	80 & 81T
			-percent-							
			APALACHICOLA RANGER DISTRICT							
1	40	N	0							
2	8	P	10.6	5.6	8.3	2.3	0	0	.7	1.3
3	14	P	22.6	11.6	19.3	3.3	0	.6	1.6	1
4	9	P	18	12.6	17	1	0	.6	5.6	.3
5	1	P	<5							
6	8	P	<5							
7	1	P	0							
8	36	N	<5							
9	5	P	0							
10	39	N	0							
11	18	N	<5							
12	15	P	28.6	15	25.6	2.3	.3	.3	.4	1.6
13	5	P	<5							
14	57	N	<5							
15	41	N	<5							
16	37	N	<5							
17	10	P	28	14	26.7	1.3	0	0	4	.6
18	20	P	<5							
19	37	N	<5							
20	2	P	0							
21	45	N	<5							
22	2	P	0							
23	4	P	<5							
24	12	P	37	16.6	33.6	3	0	1.2	3	3.6
25	40	N	<5							
26	12	P	35.6	18.3	29	6.6	0	1.8	2.6	2
27	11	P	<5							
28	36	N	0							
29	14	P	35	25.3	31.7	3	.3	0	7.3	2
30	2	P	0							
31	10	P	<5							
32	42	N	<5							
33	34	N	<5							

Table 1.--(con't)

Stand #	Age (yrs)	Origin 1/ (N,P)	Infection		Crown Rating 2/				Potential Stem Deformity 3/	
			Total	Current	a & b	c & d	e	dead-other	81T	80 & 81T
			-percent-							
			WAKULLA RANGER DISTRICT							
1	15	P	<5							
2	32	P	<5							
3	15	P	<5							
4	19	P	<5							
5	13	P	<5							
6	14	P	<5							
7	3	P	0							
8	1	P	0							
9	25	P	0							
10	17	P	<5							
11	40	N	<5							
12	34	P	<5							
13	11	P	<5							
14	6	P	0							
15	15	P	41.3	8.6	34.7	6.3	.3	3.9	1	.3
16	16	P	66	35	53.7	12.3	0	.3	.6	.3
17	7	P	<5							
18	9	P	38.6	32	27.7	9.3	1.8	0	9.3	6
19	7	P	<5							
20	6	P	<5							
21	26	P	<5							
22	26	P	<5							
23	1	P	0							
24	2	P	0							

1/ N = Naturally regenerated
P = Planted

2/ Refers to percent of crown lost to disease
a = trace
b = trace - 25
c = 26-50
d = > 50
e = dead due to pitch canker

3/ 81T = current terminal lost to disease
80 & 81T = terminal lost in successive years to disease

previous 6-9 months) was approximately one-half of the total. Lack of dramatic intensification is evidence for the endemic status of the disease on the Forest during 1981.

In most IATL stands, crowns of trees were not severely affected; i.e., disease was present on infected trees in trace amounts or involved less than 25 percent of the crown area.

Successive years of terminal kill is one measure of a tree's likelihood of sustaining a product degrading stem deformation. Only 1.9 percent of all trees in IATL stands were in this category. A better measure of future stem deformity would be to combine successive terminal kills with percent of crown damage and a subjective judgement. Such a measure should minimize the chances of misidentifying trees as deformed that might recover before harvest. Future surveys will incorporate estimations of stem deformity at the time of tree evaluation.

Mortality due to pitch canker was very low (.2% of all trees in IATL stands), while other agents (chiefly fusiform rust) killed 4 times that amount (.8%).

Trends in Disease Development, 1977 through 1981

Survey methodology in 1976 differed drastically from later surveys, and stand parameters of interest could not be collected with confidence. Therefore, discussion will center on the three most recent surveys. Available results of the 1976 survey do not contradict observations and conclusions drawn from other data collected in later surveys.

Table 2 presents the factors considered for IATL stands surveyed in 1978, 1980, and 1982. Trees were evaluated in spring, before or early during the first flush of growth. The observations made of symptoms pertain to those expressed in the previous 6 to 9 months (current symptoms) combined with those 18 to 24 months old (previous years' symptoms) at the time of the survey.

In each survey, diseased plantations were more frequently encountered on the Apalachicola Ranger District than the Wakulla. The mean age of IATL stands remained nearly constant (about 12 years), but mean infection incidence rose from about 26 percent in 1978 to 40 and 33 percent in 1980 and 1982, respectively. The incidence of infected plantations remained relatively constant in the three surveys (63-70%), but the proportion which were IATL stands declined markedly after the 1978 survey. About two-thirds of the infected plantations were IATL stands in 1978, but only one-third were in that class in surveys done in 1980 and 1982. If 1977-78 are considered epidemic years and 1979-82 a period of declining or endemic disease on the Apalachicola National Forest, it appears that one-third of the slash pine plantations on the Forest remain disease-free or lightly infected, one-third are prone to heavy infection in all years, and the remainder conditionally susceptible, depending on the stage of the disease; i.e., less susceptible during declining or endemic disease; more susceptible during rapidly increasing or epidemic disease.

Identifying characteristics of these stand types, if they exist, would assist in developing strategies to minimize the impact of the disease. Management practices could be instituted to alter stand conditions conducive to disease development or avoiding high hazard sites.

Table 2.--Certain stand parameters and management practices in pitch canker diseased slash pine plantations (≥ 5% incidence [IATL]) on the Apalachicola (A) and Wakulla (W) Ranger Districts, Apalachicola National Forest, Florida, 1982, 1980 (2), and 1978 (3).

P.C. Incid. = Pitch Canker incidence; Fert. - Fertilization; S.I. = Site Index; FT=MT = Forest Type = Future Management Type.

1982						1980 1/						1978 1/					
District, Stand #	Age (yr)	P.C. Incid. (%)	Fert. (Y,N)	S.I.	FT=MT (Y,N)	District, Stand #	Age (yr)	P.C. Incid. (%)	Fert. (Y,N)	S.I.	FT=MT (Y,N)	District, Stand #	Age (yr)	P.C. Incid. (%)	Fert. (Y,N)	S.I.	FT=MT (Y,N)
A2	8	11	N	70	Y	A1	14	64	Y	80	Y	A8	11	35	Y	80	Y
A3	14	23	N	80	Y	A2	11	15	Y	80	Y	A9	14	39	Y	80	Y
A4	9	18	Y	80	Y	A3	13	13	N	80	N	A10	14	48	Y	70	Y
A12	15	29	Y	80	Y	A4	18	42	Y	80	Y	A11	14	12	Y	80	Y
A17	10	28	Y	80	Y	A6	10	49	Y	80	Y	A12	12	44	Y	80	Y
A24	12	37	Y	80	Y	A18	9	48	Y	80	Y	A14	9	28	Y	80	Y
A26	12	36	Y	80	Y	A24	7	24	Y	80	Y	A15	19	55	N	80	Y
A29	14	35	Y	80	Y	A25	10	48	N	70	N	A20	8	6	Y	80	Y
W15	15	41	N	70	Y	W32	15	30	N	70	Y	A21	12	7	N	80	Y
W16	16	66	N	70	N	W46	13	57	N	70	N	A24	14	21	N	70	Y
W18	9	39	N	70	Y	W47	19	49	N	70	N	A25	10	13	N	80	Y
												A26	9	13	N	70	Y
												W36	21	52	N	70	Y
												W37	9	7	N	70	Y
												W39	5	14	N	70	Y
												W47	10	11	N	70	N
												W54	13	40	N	70	Y
$\bar{x}$	12.2	33				$\bar{x}$	12.6	39.9				$\bar{x}$	12.0	26.2			
FOR ALL SLASH PINE PLANTATIONS:																	
percent of stands infected					69%						70%						63%
percent of stands IATL (≥ 5% incidence)					26%						22%						41%

1/ Discrepancies in stand age as presented here and in original reports due to age as calculated from increment cores vs. age determined from planting date (N.F. records). Discrepancies in incidence data due to rounding errors or data transposing errors in original reports.

The three surveys have confirmed the observations of other investigators that natural stands are rarely diseased above trace levels. Young plantations are most susceptible. Over 85 percent of all IATL stands surveyed from 1978 through 1982 were between 8 and 16 years old.

The 1978 survey showed that the disease does not preferentially attack large or small diameter trees within infected slash pine plantations on the Forest (1).

Relationships between fertilization, site index, and suitability-for-site, as measured by the National Forest, and high or low disease incidence were not obvious. Previous work in fertilized stands showing no association with high disease incidence (R. L. Anderson, unpublished data) is supported by these survey results. Stand parameters for 1982 survey plantations appear in Table 3.

While many investigators have associated pitch canker disease with drought stress exacerbated by overstocking, this was not the case on the Forest during the survey period. Survey stands in all survey years were judged to be adequately but not overstocked. However, localized outbreaks may occur under certain unfavorable growing conditions during periods of environmental stress, leading eventually to more generally distributed disease.

Naturally regenerated stands only rarely become infected, but this management option may not be compatible with timber, wildlife, and other management objectives. More extensive data are needed to supply the necessary inputs to determine if a more useful hazard rating system can be constructed for pitch canker disease so that damage can be predicted and avoided. Evaluations of specific soil, site, stand, and environmental factors are needed to provide this information. Numerous stands with varying levels of infection already documented are available for this work.

Recent investigations by other scientists have shown that the survey method used may not provide the most accurate estimates of disease in forest stands (G. M. Blakeslee, L. G. Arvanitis, personal communication). New methods may provide more insight into disease interactions.

Surveys of the Apalachicola National Forest will be continued to provide information on future disease progress. By incorporating better methods into future surveys and correlating results with those obtained using methods of previous surveys, a more accurate picture of the disease on the Forest over time may emerge. Further insight into the disease as it operates in a population can be obtained by continuing to compile records of changes in the disease over a long period of time.

Table 3.--Certain stand parameters and management practices in slash pine plantations surveyed for pitch canker disease on the Apalachicola (A) and Wakulla (W) Ranger Districts, Apalachicola National Forest, Florida, 1982.

P.C. Incid. = Pitch Canker Incidence; Fert. = Fertilization; S.I. = Site Index; FT=MT = Forest Type = Future Management Type.

District, Stand #	Age (yrs)	P.C. Incid. (%)	Fert. (Y,N)	S.I.	FT=MT (Y,N)
A2	8	10.6	N	70	Y
A3	14	22.6	N	80	Y
A4	9	18	Y	80	Y
A5	1	<5	N	70	Y
A6	8	<5	Y	80	Y
A7	1	0	N	70	Y
A9	5	0	N	80	Y
A12	15	28.6	Y	80	Y
A13	5	<5	N	70	Y
A17	10	28	Y	80	Y
A18	20	<5	N	70	Y
A20	2	0	N	70	Y
A22	2	0	N	80	Y
A23	4	<5	N	70	Y
A24	12	37	Y	80	Y
A26	12	35.6	Y	80	Y
A27	11	<5	N	80	Y
A29	14	35	Y	80	Y
A30	2	0	N	70	Y
A31	10	<5	Y	70	Y
W1	18	<5	N	70	N
W2	32	<5	N	80	N
W3	15	<5	N	70	N
W4	19	<5	N	70	N
W5	13	<5	N	70	Y
W6	14	<5	N	70	Y
W7	3	0	N	60	Y
W9	25	0	N	70	Y
W10	17	<5	N	70	N
W13	11	<5	Y	70	Y
W14	6	0	N	70	Y
W15	15	41.3	N	70	Y
W16	16	66	N	70	N
W17	7	<5	N	70	N
W18	9	38.6	N	70	Y
W19	7	<5	N	70	Y
W20	6	<5	N	80	Y
W21	26	<5	N	70	N
W22	26	<5	N	70	Y
W23	1	0	N	70	Y
W24	2	0	N	70	Y

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